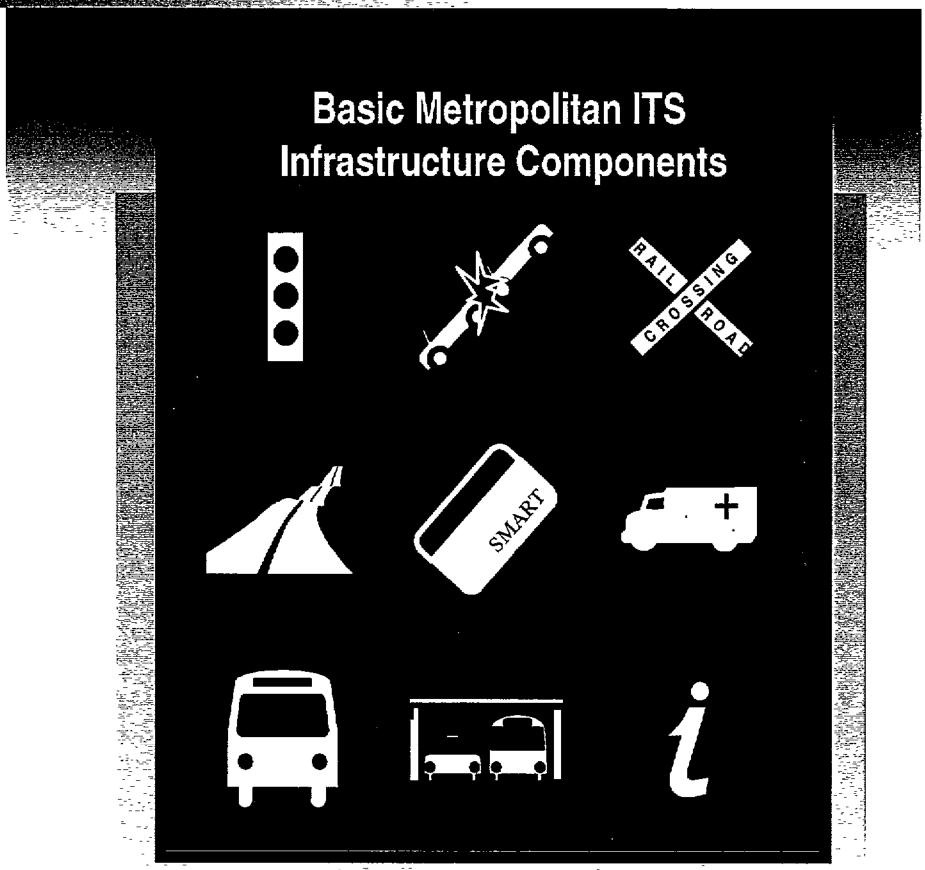
Intelligent Transportation Systems National Investment and Market Analysis

Executive Summary

ITS America
U.S. Department of Transportation



Apogee Research, Inc.
Wilbur Smith Associates

May, 1997

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ITS America
400 Virginia Ave S.W.
Suite 800
Washington, D.C. 20024-2730

Tel: (202) 484-4847
Fax: (202) 484-3483
Internet: http://www.itsa.org

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EXECUTIVE SUMMARY

The United States' transportation system is unparalleled. Yet, today, the system is straining to meet the growing demand for transportation. Planners are faced with increasing congestion, limited funds, equally limited rights-of-way, and concern for air quality. It is becoming increasingly difficult, if not impossible, to address transportation needs with traditional solutions.

Fortunately, traditional approaches are not the only solutions, nor must they stand on their own. New computing and communications applications for transportation, broadly categorized as Intelligent Transportation Systems (ITS), can help alleviate some of these problems. This study examines the opportunity afforded by these new technologies in the light of three dimensions:

1. **Benefits and Costs:** What public expenditure is required to meet national ITS deployment goals and what direct benefits may be expected by making this investment?
2. **Markets:** What are the nature, magnitude and rate of growth of ITS markets?
3. **Economic consequences:** What are the long-term economic implications of ITS deployment?

The *National Investment and Market Analysis* Study initiated jointly by ITS America and the U.S. Department of Transportation, provides the foundation for addressing these questions and more.

KEYFINDINGS

ITS encompasses a broad range of products and services that complement and enhance the performance of traditional systems. Thus, ITS generates benefits in the same categories as traditional transportation expenditures. Significantly, this study expects ITS investments to yield substantial benefits and enhanced performance in the particularly important area of safety Moreover, expenditures on metropolitan ITS systems and a rapidly expanding market for ITS applications should continue to produce operational and economic benefits at an increased rate over the next 20 years.

Benefits and Costs

ITS is unique both in terms of its high level of benefits relative to costs and in the nature of the benefits derived. This study finds that deployment of basic metropolitan ITS infrastructure represents a strong national economic investment. For example, results indicate:

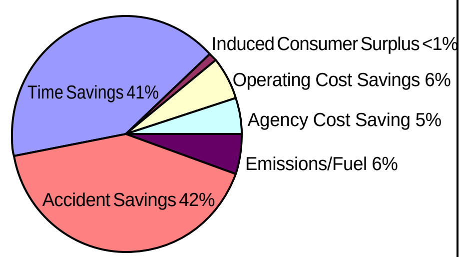
- ITS infrastructure will generate an overall benefit-cost ratio of 5.7 to 1 for the group of nearly 300 metropolitan areas examined in this study, with even stronger returns to the top 75 most congested cities (88.1 to 1).

- Present value of ITS benefits should exceed $250 billion over the next two decades.

- Unlike traditional highway capacity investments, safety benefits of ITS investments are equally as important as those derived from congestion reduction (see Figure E.1.).

- Though the level of benefits varies, ITS investments generate positive returns for all classes of metropolitan areas.

Figure E.1. Basic Metropolitan ITS Infrastructure Benefits (1996-2015)



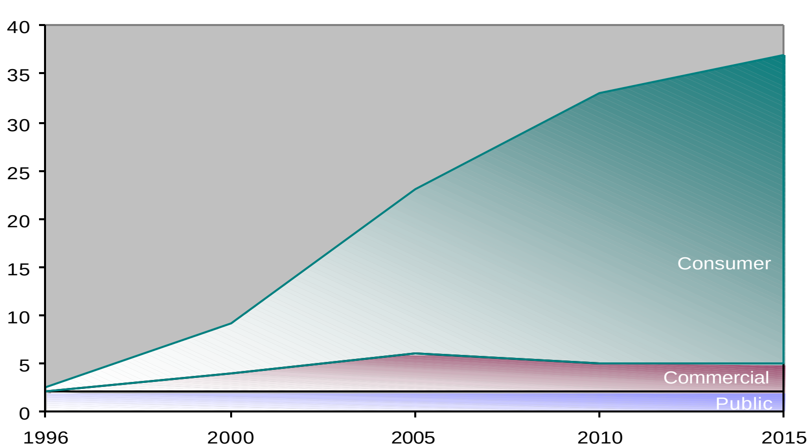
Markets

The markets for ITS products and services have grown and matured rapidly over the last five years. This growth is expected to continue and even accelerate as end-user (consumer) technologies move from early trial applications to adoption (see Figure E.2.). Other relevant conclusions include:

- Over the next 20 years, the market for ITS products and services is expected to grow and cumulate to approximately $420 billion for period.

- Building on public investments in basic ITS systems, the private market is projected to represent a smaller share initially, eventually growing to represent approximately 80 percent of all sales in the market through the year 2015.

Figure E.2. Overall Direction and Growth of ITS Market



> Public infrastructure-driven markets in U.S. metropolitan areas are projected to exceed $80 billion cumulative over next twenty years.

> Private markets, including those for consumer- and commercial-driven ITS products and services, are estimated to exceed $340 billion cumulated over the next two decades.

Economic Consequences

Direct investment in basic metropolitan ITS infrastructure is expected to result in substantial quantitative and qualitative economic consequences. Over the twenty year horizon of this study, select quantitative outcomes will include:

> $300-$350 billion in direct economic impacts, and

> Almost 600,000 jobs over the twenty-year horizon of this study.

Perhaps just as importantly, investment in transportation technologies and systems will:

> Substantially increase the safety and responsiveness of the transportation system in everything from single car accidents to hurricane evacuation, and

> Place the United States at the forefront of international competitiveness by ensuring that its transportation system remains the best in the world.

BACKGROUND

The objectives of this study are grounded in US DOT and ITS America initiatives that resulted in the adoption in late 1995 of the National Surface Transportation Goal for ITS:

To complete deployment of basic ITS services for consumers of passenger and freight transportation across the nation by 2005.

Shortly thereafter, in January of 1996, Transportation Secretary Frederico Pena announced "Operation Timesaver," a national program to deploy intelligent transportation infrastructure across U.S. metropolitan areas by the year 2005.

This study seeks to quantify the investments and benefits associated with the realization of these objectives in metropolitan areas across the country. The focus is on the costs and benefits of deploying "basic metropolitan ITS infrastructure" in 297 large, medium and small metropolitan areas by 2005. More specifically, the study:

> Clarifies the strategic direction and rationale for ITS investments by public agencies in large, medium and small metropolitan areas,

> Identities likely costs, benefits and risks associated with these investments;

- Projects the size of the market for ITS services and products over the next two decades, and
- Estimates the potential national economic impacts of public investment in deploying basic ITS metropolitan infrastructure nationwide.

SCOPE AND METHODOLOGY

This study focuses on one element of ITS: basic metropolitan ITS infrastructure. In this context, the study evaluates four key issues:

1. Public sector investment required to satisfy national metropolitan deployment goals,

2. Potential for private sector investment based on alternative public sector investment scenarios,

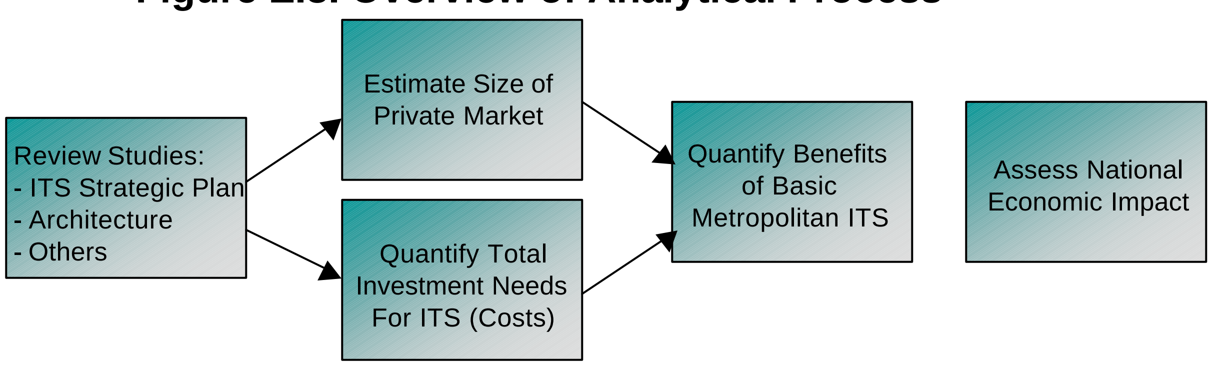
3. Relationship between the cost of deploying individual ITS components and associated benefits, and

4. Potential impacts of all benefits, direct and indirect, on the overall economy resulting from investment in basic metropolitan ITS infrastructure.

It is also important to understand what is *not* addressed. The study does not seek to estimate the costs to deploy all possible ITS systems. Commercial vehicle, rural, and automated highway systems are not addressed in this study. This study does not attempt to estimate the cost to deploy ITS in a given city. Instead, it draws on national data and research to estimate the costs and benefits of deploying basic metropolitan ITS infrastructure nationwide. And, finally, this study does not attempt to estimate relative financial roles of public agencies (federal, state, and local) in paying for basic ITS services.

Figure E.3 presents an overview of the analytical process for this study. The process started with an in-depth review of the literature on ITS costs, benefits and markets.

Figure E.3. Overview of Analytical Process

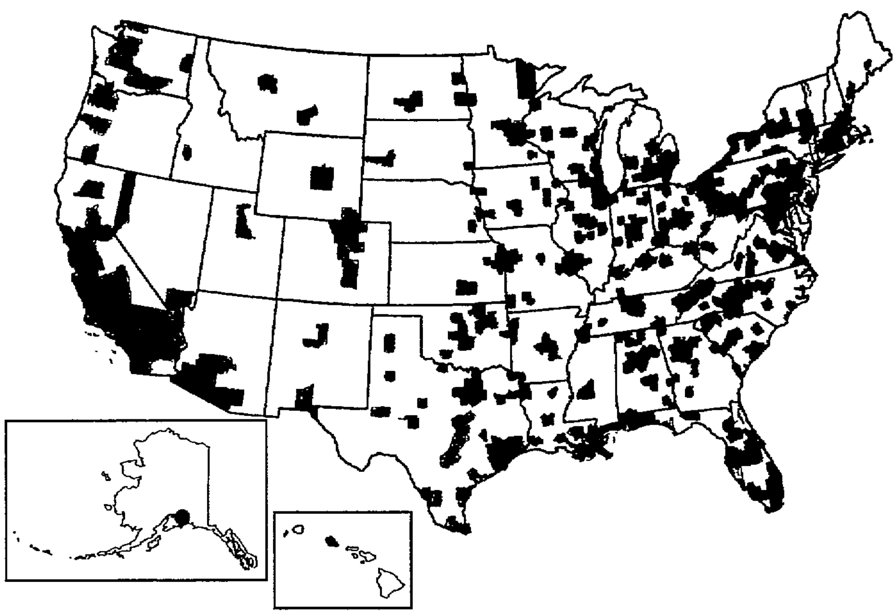


Drawing on this review, estimates were developed of the total investment needed to achieve the goal of full deployment of basic ITS services in metropolitan areas nationwide by 2005. This task focused on analyzing public sector costs for deploying the ITS infrastructure, as well as evaluating the private sector market opportunities for infrastructure- and consumer-driven needs. The projected public sector costs reflect the total investment required to meet the policy objective of full deployment by 2005. Projection of direct (operational) benefits associated with investment in basic metropolitan ITS infrastructure was based on empirical data on project-level benefits.

The national economic consequences of full ITS deployment were estimated based on a comparison of the estimates for investment requirements (direct costs) and direct benefits. The analysis also considered macroeconomic impacts of ITS such as multiplier effects and competitiveness consequences.

Figure E.-l. depicts the geographic coverage of this study. In all, 297 different large, medium and small metropolitan areas from across the United States were included in this study.

Figure E.4. Coverage of U.S. Metropolitan Areas



KEY FEATURES

In addition to the analytical process outlined above, the output of this study includes three features designed to ensure the flexibility, validity and applicability of the findings:

1. *Models.* Models for costs, benefits, and market forecasts were designed using spreadsheet software to facilitate both scenario analysis and updates to inputs and assumptions.

2. *Review Process.* The study was subjected to an extensive review process designed to ensure stakeholder.technical critique of all steps undertaken for this study. Over the course of the study, dozens of public sector and private sector ITS experts were consulted through expert panels, committee meetings and individual interviews for their input and review of the methodologies and findings.

3. *Application of Ongoing Research Activities.* The study drew on secondary information from a wide range of research publications and other nationally recognized documents, including the U.S. DOT National Architecture, benefits estimates across ITS systems compiled by Mitretek Systems, and hundreds of other studies.

METROPOLITAN ITS INVESTMENT REQUIREMENTS ("COSTS")

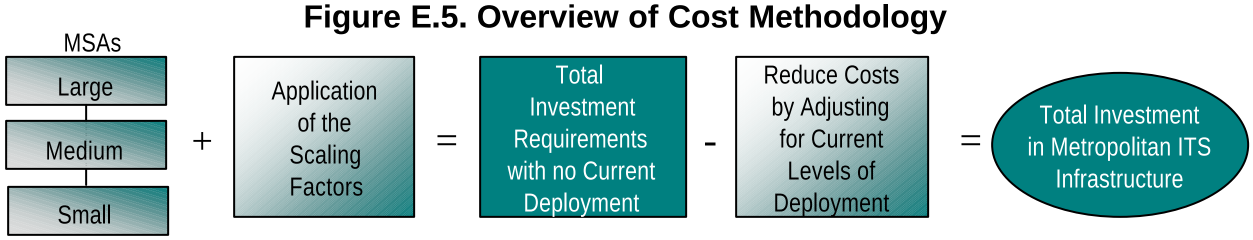
The focus of this study was on the basic metropolitan ITS infrastructure. The overall analytic approach to the cost estimation task included four steps, as shown in Figure E.5.:

1. Application of National ITS Architecture Program estimates to identify representative large metropolitan TIS infrastructure requirements; [1]

2. Development of representative requirements for other medium and small metropolitan areas;

3. Development of scaling factors for estimating costs by metropolitan statistical areas (MSAs); and,

Figure E.5. Overview of Cost Methodology

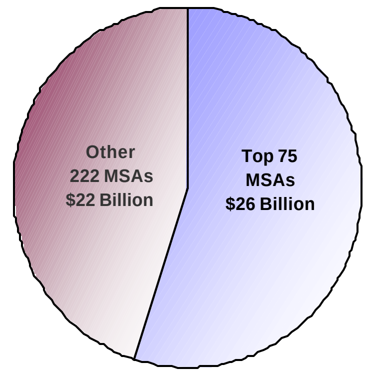


[1] National ITS Architecture. United States Department of Transportation, 1996.

4. Application of current deployment status assumptions to aggregated costs to estimate net national investment requirements.

Figure E.6. summaries the total investment requirements to realize the national goal of full metropolitan deployment of basic ITS services by 2005. As shown in Figure E.6., over 50 percent of the total investment needed is for deploying basic metropolitan ITS infrastructure in the 75 metropolitan areas. Between 1996 and 2005, approximately $48 billion of investment in both capital and operating expenditures is required to realize the national deployment goal.

Figure E.6. Total Investment



Total Metropolitan ITS Investment
$48 Billion

Table E.1. summarizes the key findings from the cost analysis phase of the study. The table presents the recurring costs for operating and maintaining the basic infrastructure beyond 2005. [2]

Table E.1. Investment Analysis: Overall Findings ($Billions)

Category	Non-Recurring Costs		Recurring Cost		Total Costs		Present Value
	1996-2005	2006-2015	1996-2005	2006-2015	1996-2005	1996-2015	1996-2015
Top 75 Metropolitan Areas	$16.5	$0.0	$9.8	$19.7	26.3	$46.0	$24.1
Other	$13.8	$0.0	$8.2	$16.5	22.0	$38.5	$20.1
Overall, Basic	$30.3	$0.0	$18.1	$36.2	48.3	$84.5	$44.2

[2] Since a significant time lag is anticipated between physical and the realization of full benefits potential, the period of analysis was extended to 2015.

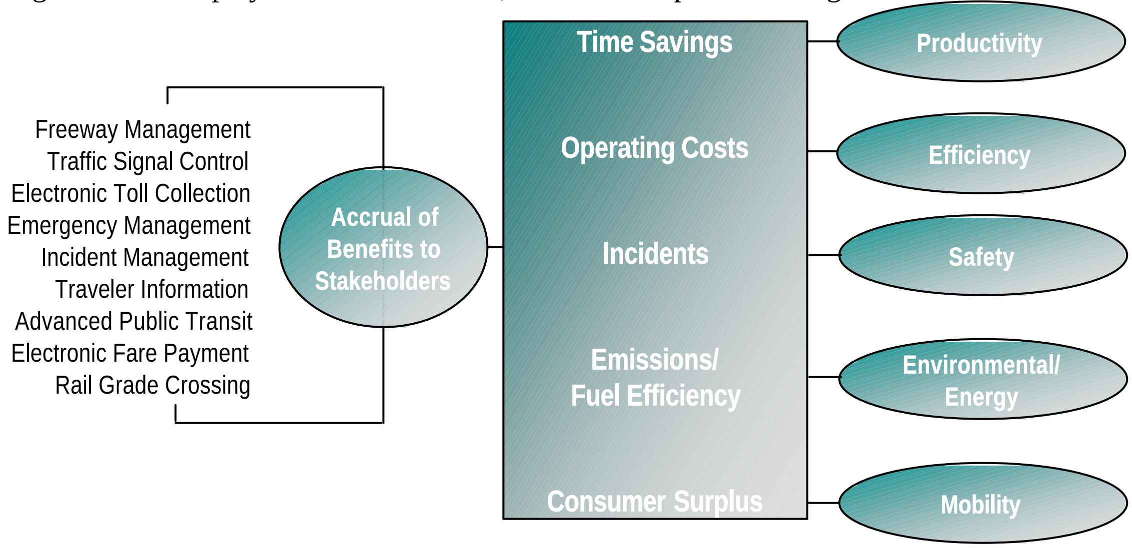
BENEFITS

Estimating the national benefits of basic metropolitan ITS infrastructure deployment is challenging for a number of reasons, including:

- ➢ Most existing TIS project analysis and benefits estimation has focused on corridor - or project-level findings, resulting in limited information on benefits at the state, regional, or national level;
- ➢ The breadth and diversity of reported TIS benefits - and the factors that drive these benefits - are highly dependent on local circumstances, thus limiting application of these findings to the national level'
- ➢ The diverse technological research of basic metropolitan ITS infrastructure across all modes of transportation affects the entire spectrum of stakeholders, from society as a whole to infrastructure operators and fleet managers, to individual travelers; and,
- ➢ While each of the individual investment benefits are important and can be considered separately, many benefits are inter-related, such as those between incident response and traveler information systems.

The analysis of benefits undertaken for this study acknowledges these limitations, and is based on an estimation methodology that is flexible and capable of being updated over time as better data on ITS benefits become available. It is designed to reflect the linkages between various ITS technologies and potential benefits to the nation' s overall transportation system as articulated in the national goals for ITS deployment. To the extent possible, the estimates are based on conservation assumptions, which in turn are derived from the low to medium range of benefits documented in various field and operational tests of ITS applications (technologies and services).

Figure E.7. presents an overview of the linkages between various ITS applications and the national goals of ITS deployment. As illustrated, the measures provide a tangible tool with



which to communicate the effectiveness of each respective deployment in meeting one or more of the prescribed ITS goals.

Figure E.8. summarizes the methodology for estimating national ITS benefits. The basic metropolitan ITS infrastructure benefits were estimated for three broad categories:

1. Traffic management;
2. Advanced public transportation systems; and,
3. Rail grade crossing.

In addition, some of the key components of the analytical procedure for benefit estimation included:

- A model of estimate direct benefits of basic metropolitan ITS deployment designed to facilitate sensitivity analyses of a wide variety of underlying assumptions.
- ITS direct benefits projections for each of the 297 MSAs individually, based on MSA-specific transportation characteristics.
- Key measures of the potential benefits of various basic metropolitan ITS infrastructure components based on studies that reported actual or expected benefits from basic metropolitan ITS infrastructure deployments.

The present value of benefits of deployment of basic metropolitan ITS infrastructure ranges from $227 billion to $265 billion between 1996 and 2015, with the variance a function of the current level of ITS deployment.

Figure E.8. Benefits Estimation Overview

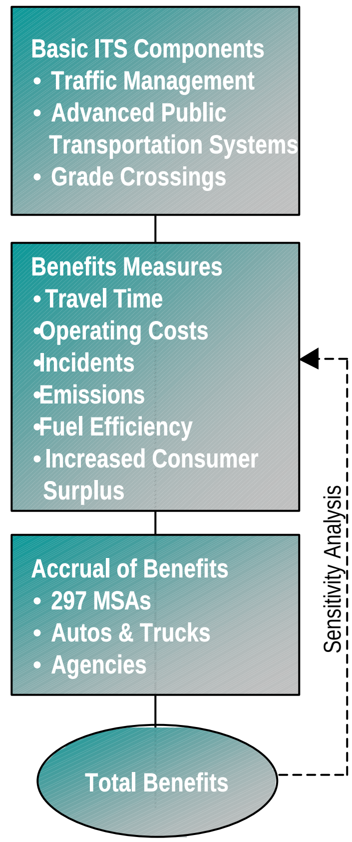
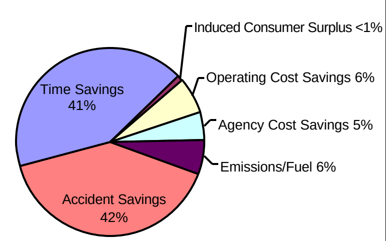


Figure E.9 presents total benefits by each of the six major benefits measures. Over 80 percent of the estimated benefits are attributed to safety improvements and congestion reduction, while the remaining four benefits measures account for slightly under 20 percent of all benefits. An analysis of benefits by MSA-type also indicates that a majority (84 percent) of all benefits from metropolitan ITS deployment accrue to the 75 largest MSAs, while the other 222 MSAs realize approximately 16 percent of total benefits.

Figure E.9. Basic Metropolitan ITS Infrastructure Benefits (1996-2015)



BEFITS VS. COSTS

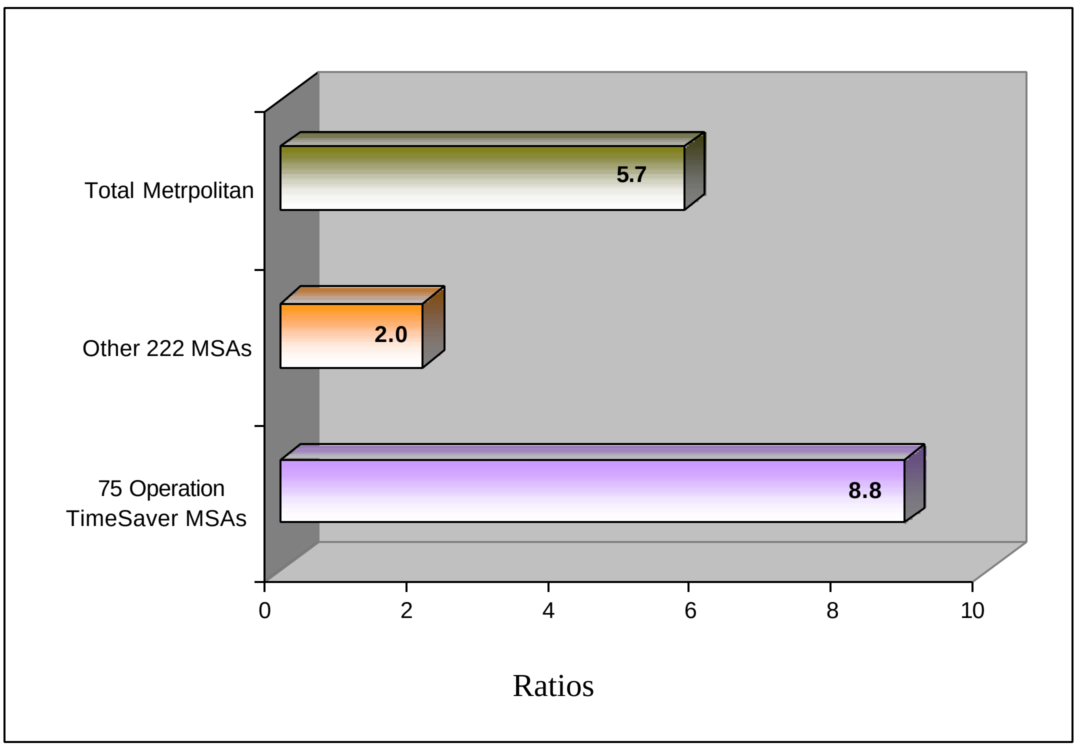
Table E.2. summarizes the costs and benefits associated with deployment over a twenty-year period and presents the benefits-cost ratios derived from the analysis.

Category	Costs (Billions)	Benefits (Billions)	B/C Ratio
75 operation TimeSaver	$24.1	$212.5	8.8
Other 222 MSAs	$20.1	$39.1	2.0
Total Metropolitan ITS Infrastructure	$44.2	$252.0	5.7

Source: Apogee Research, Inc.

As shown in Figure E.10., the benefit-cost ratio ranges from 2.0:1 for the 222 small, medium and large MSAs to 8.8:1 for the largest 75 MSAs.

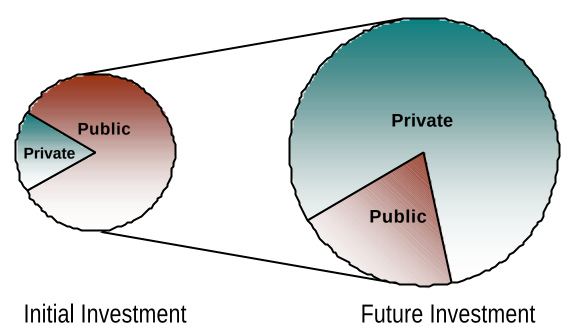
Figure E.10 Metropolitan Benefit/Cost Ratios



ITS MARKET PROJECTIONS

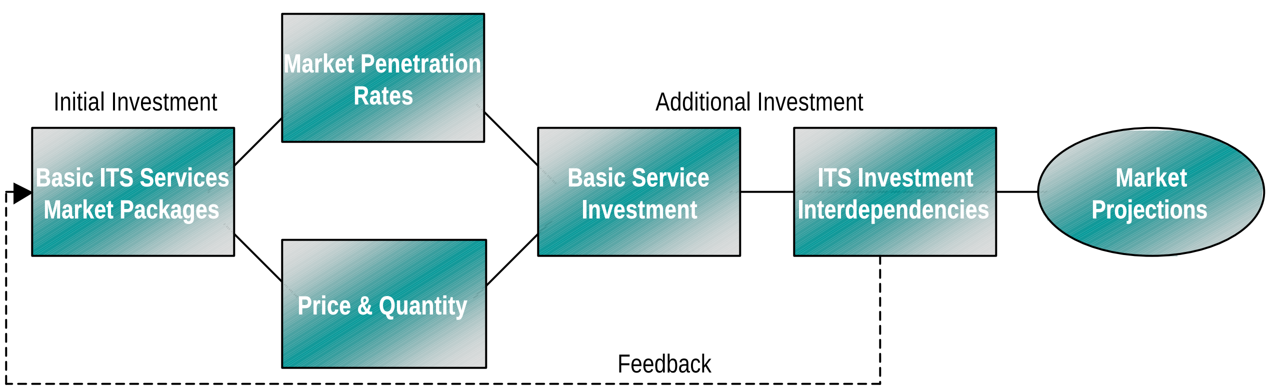
At the time of ITS America’ s first ITS Strategic (*ITS Strategic Plan in the United States, 1992),* private investment was ultimately expected to represent some 80 percent of all ITS investment. This expectation still holds, as evidenced by the market analysis presented in this study. However, as shown in Figure E.11., the implementation of the National Deployment Goal is expected to emphasize public investments in the early years. This investment in basic metropolitan ITS infrastructure must be undertaken strategically to establish the foundation for value-added products and services in the future. With the basic infrastructure in place, the private sector can assume its leadership role in directing services to consumers. It is in this way that an initial investment can ultimately lead to private potential, as shown in Figure E.11.

Figure E.11. Leverage Potential of Public Sector Investment in Basic Metropolitan ITS



Source: Apogee Research, Inc.

This analysis employs a combination of methods, including projections of existing demand, interviews, a review of existing literature, and forecast of market penetration and price. In all cases, estimates are based on conservation assumptions regarding available products, prices, and penetration rates. Figure E.12. illustrates the basic estimation procedures for deriving total market projections.



Source: Apogee Research, Inc.

Total market opportunities reflect a combination of the basic metropolitan ITS market (driven by public investments) plus the response of private sector willingness to invest. Three key parameters were used to estimate the total market size:

1. *Target Market Base:* The market base that can be targeted potentially by providers of the ITS product or service. For example, the market base for in-vehicle

system could either be the total number of registered vehicles, the projected number of new car sales, or both, if the product accommodates retrofits.

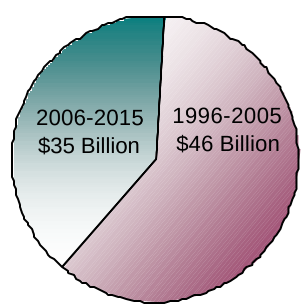
2. *Penetration rate:* the degree to which the vendor can capture the target market base for the products or services offered. For example, a five percent market penetration suggests that five out of every 100 potential customers are willing to pay for a particular product or service. market penetration rates change over time, depending on a range of factors such as price, perceived value, and technology trends.

3. *Price:* the cost of the product to the customer or end-user. This may be adjusted; for example, as has been the case in all technology markets, the prices of most ITS products and services are expected to continue to fall.

Total market size is a product of the unit volume (derived by multiplying the target base by penetration rate) and the price. Like the models developed for the investment analysis, the market analysis models can be modified as new information becomes available.

Figure E.13. summarizes the total market estimates for the public-led, infrastructure-driven market between 1996-2015, which are expected to exceed $80 billion over the next two decades. Between years 2006 and 2015, the market growth slows as net new public investments in capital expenditures are expected to decline.

Figure E.13. Public-Led Market Projections (1996-2015)



1996-2015 Public-Led Market
$81 Billion
(Constant Dollars)

Table E.3. depicts the cumulative market-size projections for the key private-led markets in two separate time-periods (1997-2005 and 2006-2015) and the total private-led market potential over the twenty-year horizon.

Table E.3. Summary of Private-Led Market Projections

Category	Private-Led Market Projections (Constant 1996 $Billions)		
	1997-2005	2006-2015	Total
Driver Vision Enhancement Systems	$2	$42	$44
Driver Safety Monitoring Systems	$2	$27	$29
Vehicle Safety Monitoring Systems	$2	$8	$9
Obstacle Warning Systems	$5	$54	$59
Fleet Tracking	$17	$34	$52
Mayday Systems	$21	$50	$70
Route Guidance and Information*	$12	$69	$81
Total	***$61***	***$283***	***$344***

*includes service fees for electronic toll and fare payment systems.

These projections suggest four conclusions about the private-led market. First, the market potential for almost all different products and services examined rises significantly in the latter period (i.e., 2006-2015) as technology matures. This difference is more noticeable for the advanced vehicle control and warning systems, since most of these products are now in testing and expected to be introduced only after the turn of the century.

Second, three key products and services drive the total private-led market over the next ten years: Route Guidance and Information Systems; Mayday Support Systems; and Fleet Tracking and Management Systems. Considerable advances in these technologies have already been achieved, and clear market opportunities exist for vendors of such systems in the near-term.

Third, Obstacle Warning Systems seem likely to dominate the advanced vehicle systems market. Recent research on various crash avoidance systems by the National Highway Traffic Safety Administration has helped spur significant investment in these systems by most major vehicle manufacturers.

Finally, the total market for all private-led products and services exceeds $340 billion over the next twenty years. Clearly, significant market opportunities exist for those private sector firms undertaking the necessary investments today to mitigate for technology and market risks.

The findings from this study indicate that total market opportunities, including both the public-led and private-led markets, will exceed $320 billion over the next two decades, with important differences among applications in the speed with which the markets evolve.

NATIONAL ECONOMIC CONSEQUENCES

Figure E.14. provides an overview of the analytical framework used to identify and estimate the major economic impacts of investment in basic metropolitan ITS infrastructure. Impacts are organized under two broad categories: (a) Macroeconomic Effects and (b) Transportation System Efficiency Gains. Under Macroeconomic Effects, this study focused on quantifying two impacts: employment and economic multiplier, with a qualitative assessment of the other impacts. It should be noted that productivity gains, for example, were not quantified. As a result, the macroeconomic estimates should be considered conservative. All the impacts identified under Transportation System Efficiency Gains were quantified in the study. For example, the analysis of benefits discussed in the earlier section estimates the impact of ITS on:

- Time savings,
- Operating costs,
- Incidents and accidents, and
- Emissions and fuel efficiency.

Figure E.14. Study Findings and Impacts

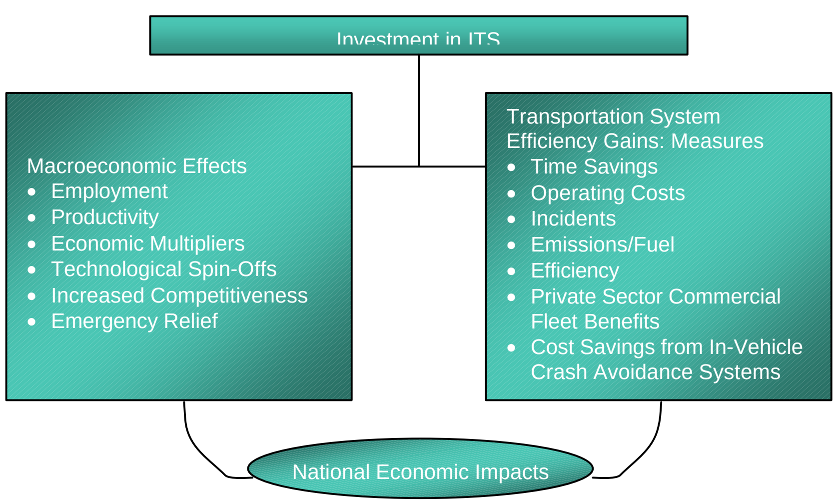


Table E.4. summarizes the key findings.

Table E.4. Selected Impacts of ITS Investment

Impact	Approach	Estimates	Time Period
Employment	Highway 1 Direct Employment Estimation Model*	590,000 Direct jobs	1997-2015
Economic Multiplier Effect	Application of traditional multiplier estimates available in the literature	$300-$350 Billion	1997-2015
Direct Benefits	Benefits Estimation Model developed as part of the study process	$252 Billion (present value)	1997-2015
Private Sector Market	Market forecasts developed as part of study process	$342 Billion	1997-2015
Private Sector Commercial Fleet Benefits	Benefits Estimation Model developed as part of the study process	$96 Billion (present value)	1997-2015
Cost Savings From In-Vehicle Crash Avoidance Systems	Application of the findings from the NHTSA Report	$27 Billion	Annual

*Developed by Apogee Research, Inc. 1995

In addition to the impacts identified above, a range of other qualitative and intangible impacts were identified that may be attributable to the national deployment of basic metropolitan ITS infrastructure. These can have significant economic and safety implications, including:

- Enhanced global competitiveness (through reduced transport costs),
- Improved infrastructure utilization,
- Private sector productivity (just-in-time, access to labor markets),
- Technological spin-offs and by-products,
- Quality of life impacts (leisure, reduced driver stress, etc.), and
- Emergency and disaster-relief operations.

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Prepared by: Apogee Research, Inc.
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